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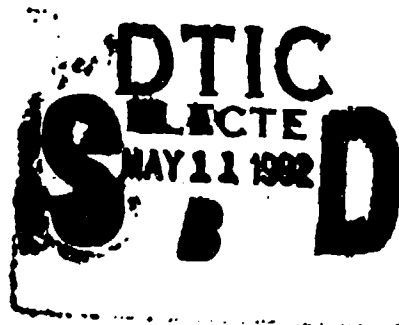
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NP PAB METHODOLOGIES (NPPABINT)

ANNUAL REPORT

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FOREWORD

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INTRODUCTION

The Thermal Stress Program area of the Naval Medical Research Institute was tasked to develop and test technology for integrating Performance Assessment Battery (PAB) tasks with components of the Neurophysiological Performance Assessment Battery (NP-PAB). The goal was to develop PAB tasks that would directly control elements of the NP-PAB, with both software systems inhabiting the same hardware environment. The system should also have the ability to store and analyze both PAB and evoked potential data.

A set of system requirements was generated and a vendor was identified who could meet the specifications. The contract was awarded during June 1990 to Man-Made Systems Corporation of Columbia Maryland.

GENERAL SYSTEM SPECIFICATIONS

The proposed system is an integrated package of off-the-shelf hardware, off the shelf system software and custom-designed application software. It supports the following general functions:

- the real-time amplification and digitalization of multi-channel, physiological signals, namely the ongoing electroencephalogram (EEG), stimulus-locked event-related potentials (ERPs), and ongoing electrooculogram (EOG),
- the concurrent acquisition of event marker pulses (either digital or analog, and usually denoting the occurrence of a task-relevant stimulus) from PAB system software.
- off-line acquisition of behavioral data from the PAB system (via a serial communication port),
- user-directed analysis of the physiological data in order to relate derived physiological measures to behavioral performance.

The package runs on an IBM-compatible, PC-386 work station. The system will provide both derived wave forms and quantifying measures in formats that can be readily ported into a statistical analysis software package or sent via a serial communications port to a plotter.

The system will provide the following features in an integrated, package :

- Amplification of up to 24 channels of physiological data with software selected amplifier characteristics.
- Analog-to-digital conversion of the amplified signals,
- Real-time display of the incoming physiological signals, allowing the experimenter to monitor the data acquisition process,
- Hard-disk storage of digitalized physiological signals along with PAB event-markers.
- Off-line acquisition of PAB behavioral data via an RS-232 serial communications port.
- Off-line analysis of the physiological signals, including digital filtering; sorting of physiological data into categories defined by behavioral task conditions, stimuli, and user responses; quantifying of EEG and EOG with selected time series analyses, including the calculation of "brain maps" and compressed spectral arrays; identification of EEG and ERP epochs contaminated by concurrent EOG (or EMG) activity; averaging of ERPs time-locked to PAB events; quantifying of average ERPs in terms of wave form component amplitude, latencies and scalp distributions; single trial quantifying of ERPs and the computation of

- latency corrected average ERPs,
- Off-line display of single-trial ERPs and EOG, stimulus-locked average ERPs and EOG, and summary derived measures.
- Menu-driven user-system interface with on-line help, error checking of user entries, and diagnostic error messages,

Each of these features are implemented with a number of options for user-directed data processing. The goal is to give the physiological data analyst a variety of tools for exploratory data analysis, with visualization of both raw and derived wave forms, as well as derived measures.

HARDWARE SPECIFICATIONS

- PC-80386-20 mhz processor, IBM-AT compatible, 4 mbyte random access memory, built in VGA graphics adapter, mouse port, and serial/parallel communications port (RS232 standard) (for receiving behavioral performance data from the PAB system and for interfacing to standard printers and/or plotters).
- Internal hard disk, at least 70 mbyte capacity, at most 28 msec access time.
- Internal 5 1/4" floppy disk drive,
- 60 mbyte internal streaming tape drive (for back-ups, and data archive).
- 80387 math co-processor.
- High resolution, multi-sync, VGA color monitor.
- 101-key keyboard.
- Mouse pointing device.
- 24 channel amplifier package (Lexicor Neurosearch-24), with complete subject isolation (for electrical safety), selected filter settings, selected sensitivity, automatic data calibration.
- Multi-function I/O board (with 12 bit A-to-D converter, D-to-A converter, digital I/O, clock/counter).
- Electrode continuity box.

SOFTWARE SPECIFICATIONS

OPERATING SYSTEM:

- DOS 3.3 operating system,

APPLICATION:

- A-to-D conversion:
User-specified number of channels, sampling rate.
Event-markers accepted either analog or digital.
- Real-time display of incoming digital data:
User-specified set-up of channels, gain of display.
Simultaneous display of 1-24 channels of raw signals.
Logging of data to disk can be enabled or disabled,
- Off-line acquisition of behavioral data from PAB:
Inspection of PAB data files,
- Visual inspection of "raw" wave form data:
Playback of ongoing EEG and EOG that was streamed to disk.
Single trial display of ERPs and concurrent EOG,
Display of 1-24 channels of digitally filtered signals,
Spectral power plots of 1-24 channels of data with Fast
Fourier Transform analysis and user-definable referencing
modalities.
Topographic "brain maps" in color.
- Selected time-series analysis of ongoing EEG and EOG
epochs:
Spectral analysis in the frequency domain.
Bipolar or referential measurements,
Compressed spectral arrays,
Topographic "brain mapping."
Amplitude asymmetries between user-specified pairs of scalp
channels.
Coherence between user-specified pairs of scalp channels.
- Computation of average ERP and EOG wave forms
time-locked to the occurrence of PAB stimuli:

User-specified data sorting parameters, based on PAB task
conditions, behavioral data, and/or subject's responses.
Rejection of individual raw data epochs based on
user-specified root mean square levels for selected channels
(thus allowing data contaminated by EOG or EMG activity to
be purged).
Identifying information stored with the average wave forms.
Optional user-specified FIR filtering of raw data prior to
averaging.
Optional latency correction procedure applied to ERPs.

Examination of Average Wave Forms:

Optional user-specified FIR filtering before display.
User-specified layout and scaling on the screen.
Digital display of wave form amplitudes and latencies by
cursor control upon request.

Merging/collapsing of average wave forms:

Across-subjects (grand averages) or within-subjects
averaging.

Weighted or uniform averages and standard deviations.

Optional user-specified merging on the basis of identifying
information stored with the average wave forms.

Merging/collapsing of either conventional or
latency-corrected average wave forms.

Computation of baseline-to-peak (BTP) area measures and peak
latencies of average waveforms.

User-specified search epochs for peak identification.

Recognition of absolute peak center time point or center time
point determined by peak within a specified time epoch.

Optional user-specified FIR filtering before peak detection.

Output of derived wave form measures in a format compatible with
standard statistical software packages.